GCID

PROJECT REPORT

AUTOMATIC NUMBER PLATE DETECTION

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Abstract

The ANPR system is a state-of-the-art machine learning-based solution that can accurately detect and recognize number plates and human faces from poor-quality images. The system leverages a range of modules, including object detection, image pre-processing, character recognition, and face recognition, to identify number plates and drivers' faces in video footage automatically. The system uses cascading coupled with a sliding window technique to detect number plates, and the processed number plate image undergoes layers of Convolutional Neural Networks (CNNs) to perform Optical Character Recognition (OCR) and identify the number plate text.
ANPR allows for accurate identification of number plates making it an ideal solution for law enforcement and surveillance purposes.

Brief Introduction

India is currently facing a serious issue where over speeding violations result in a death every four minutes. Additionally, criminals often use stolen vehicles to evade law enforcement, and identifying and tracking suspects from low-resolution CCTV footage can be a complex task. While the installation of high-resolution cameras at every public and private space in the country could potentially solve this issue, it may prove to be too costly and resource intensive.
To address these challenges, we propose a Machine Learning (ML) based solution that utilizes number plate recognition.

ANPR (Automatic Number Plate Recognition), also known as ALPR (Automatic License Plate Recognition), is a technology that is used to automatically capture, analyse, and interpret license plate information from vehicles. It is an advanced system that combines optical character recognition (OCR) and pattern recognition techniques to extract alphanumeric characters from license plates and convert them into machine-readable data.

ANPR systems typically consist of cameras, image processing software, and databases. The cameras are strategically positioned to capture images of passing vehicles and their license plates. The images are then processed using sophisticated algorithms to detect and segment the license plate region, isolate the characters, and recognize the alphanumeric information on the plate.

The key components and processes involved in ANPR systems are as follows:

Camera Systems: The camera systems can be fixed or mounted on vehicles, toll gates, traffic poles, or surveillance systems. In some cases, infrared cameras are employed for night vision or to enhance image quality in low-light conditions.

Image Processing: The captured images go through several steps of image processing. These include preprocessing techniques such as noise reduction, image enhancement, and normalization to improve the quality and clarity of the license plate region.

License Plate Detection: Through the use of image analysis and pattern recognition algorithms, the system identifies and localizes the license plate region within the image. This process involves techniques like edge detection, contour analysis, and morphological operations.

Character Segmentation: Once the license plate region is detected, the system segments individual characters or groups of characters on the plate. This step involves methods such as connected component analysis and contour-based segmentation.

Optical Character Recognition (OCR): The segmented characters are then passed through the OCR algorithm, which recognizes and interprets the alphanumeric information on the license plate. OCR techniques employ pattern matching, feature extraction, and machine learning algorithms to accurately recognize the characters.

Data Storage and Retrieval: The recognized license plate data, along with the corresponding date, time, and location information, is stored in a database for future reference and analysis. This allows for efficient retrieval and search capabilities when required

Objective of the Project

The objective if this project is to create an Automatic Number Plate Recognition (ANPR) system which is designed to automatically detect the number plate in a video footage and perform character recognition on the number plate text.

This system comprises several modules, including object detection, image pre-processing, character recognition. The object detection module leverages cascading coupled with a sliding window technique to detect number plates in video frames and create bounding boxes around them. Subsequently, the processed number plate image undergoes layers of Convolutional Neural Networks (CNNs) to extract image features, perform Optical Character Recognition (OCR), and identify the number plate using an API(*Application programming interface)* key.

The ANPR has numerous applications,

1. Enhancing Law Enforcement: The project aims to support law enforcement agencies in detecting and apprehending vehicles involved in criminal activities by providing real-time license plate recognition and tracking capabilities.
2. Improving Traffic Management: The objective is to develop an ANPR system that can monitor and manage traffic flow more efficiently by identifying traffic violations, monitoring congestion, and analyzing traffic patterns.
3. Enabling Parking Management Systems: The goal is to implement ANPR technology to automate parking systems, enabling automatic entry/exit management, accurate billing, and efficient parking space allocation.

Hypothesis

The hypothesis section states the expected outcomes or results of the ANPR project based on the objectives defined.

1. Improved Law Enforcement: Implementing an ANPR system is expected to increase the identification and tracking of vehicles involved in criminal activities, leading to a higher detection rate and quicker response from law enforcement agencies.
2. Enhanced Traffic Management: The hypothesis could be that deploying an ANPR system will result in improved traffic flow, reduced traffic violations, and better decision-making regarding traffic management strategies.
3. Efficient Parking Management: The hypothesis might state that implementing ANPR technology will lead to streamlined parking operations, reduced manual intervention, and improved accuracy in parking space allocation.

Approach methods and Outcomes of the methods

Searched and looked into different pre-existing optical character recognition (OCR) models such as EasyOCR, Py-tesseract, Simple OCR etc.

Learnt from output that none of the pre-existing OCR models will work as the image quality of the input images were of very low quality.

Thought of a different approach of first enhancing the very low-quality images into high quality using multiple algorithms like SCRNN, GAN, CNN and then to use existing OCR. This method included removing the noise, gradient blur, motion blur and then enhance the image quality.

In this method many algorithms or models didn't work at all as they were unable to build new pixels based on the few existing pixels data.

The models which did work, but didn't give very promising results. They did enhance the quality of the image but not the manner in which any human could read nor in a manner any OCR would recognize.

Hence, we broke down the task into two stages which were number plate detection and character recognition of the detected number plate.

In the first stage of number plate detection, we tried algorithms such as face-net, YOLO, SSD, Haar-Cascade and R-CNN.

From the above algorithms, only Haar-Cascade gave promising results as haar-cascade could work with less amount of dataset. Haar-Cascade was meant for facial-recognition which was further optimized for number plate detection.

In the character recognition, we tried to understand the implementation of OCR models. We discovered the Gaan model and transformer technologies which are currently used in advanced OCR systems and NLP systems such as Google cloud vision and Amazon cloud for vision etc.

Current plan of action for implementation

In the plate detection, we fine-tuned the haar-cascade model which detects majority of the car number plates, when changes are made with the scale factor. This scale factor can be automated in the future.

For the Optimal Character recognition, we requested and got the google cloud vision API access for student. We then found another Vision platform which was nano Nets API then we had requested for the API access and started to integrate

both the Google cloud vision and the nano nets API with the haar-cascading model for object detection.

Expected result

This complete system gives better results of number plates. The number plates which are of bad quality are also recognized. The following video and image describe the outcome.

- https://drive.google.com/drive/folders/1WQjJit7jI4X_b31APN6xKqSBMuVHXtHJ
- https://github.com/Hitaishkg/ANMR_GCID

Future scope or recommendations

The project can be extended to other vehicles such as auto rikshaws, which do not have a fixed number plate. Many features can be added to the system like predicting a possible range of numbers from the number plate for better efficiency. The OCR can be built using a model instead of using a pre-built model and APIs'.

References

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- https://github.com/ocropus/ocropy
- https://github.com/googleapis/python-vision
- https://github.com/NanoNets
- https://docs.opencv.org/4.x/